White Paper

Separation for Increased Safety: Independent Level and Overflow Control Compliant with the Forthcoming IGC Code

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Abstract

There is a critical need for increased safety on vessels transporting liquefied gases in cryogenic tanks. Owners and operators of gas carriers must adhere to the International Maritime Organization (IMO) regulation known as the International Code of the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code). The purpose of this code is to provide an international standard for the safe carriage, by sea in bulk, of liquefied gases. Misunderstandings about this regulation have resulted in the development of solutions where safety features, such as overflow control, are combined with the liquid level gauging system. However, the Society of International Gas Tanker & Terminal Operators (SIGTTO) recognized the need for clarification some years ago. In response, they published the "ESD Systems – Recommendations for Emergency Shutdown and Related Safety Systems," which clearly state that the liquid level gauging system and the safety functions must remain completely separate and independent. The intention has been to eventually incorporate this clarification into the forthcoming revision of the IGC Code.

Introduction

This white paper explains how a fully radar-based solution – the complexity and costs of which can be reduced by using innovative 2-in-1 technology – can be implemented to provide this clear separation, thereby significantly increasing safety.

Liquefied gases are stored in specialized tanks and transported overseas using purpose-built gas carriers. Accurate and reliable measurements of the liquid level inside each tank are crucial for inventory management and custody transfer, which are achieved through a tank gauging system. To minimize risk, tanks must also be equipped with a robust safety system designed and implemented in compliance with relevant IMO regulations. Traditionally, on gas carriers, the safety system's functionality has been kept separate and independent from the tank gauging system. However, perceived ambiguities within the regulations have recently led to the implementation of solutions that integrate safety functionality within the tank gauging system, aiming to reduce costs. As a result, SIGTTO seeks updates to the relevant guidelines and regulations to eliminate the possibility of interpretations that contravene its true intent. SIGTTO's 2021 publication, "ESD Systems - Recommendations for Emergency Shutdown and Related Safety Systems," states that to minimize risk and enhance safety, gas carriers should not be allowed to employ solutions where safety functionality is integrated into the tank gauging system. If approved and implemented, this change would first apply to new gas carriers and eventually to existing ones.

The Need for Increased Safety

Virtually all liquefied gases are flammable hydrocarbons, so a tank filled above its capacity, causing a spill, presents an obvious safety hazard. The consequences of a spill can be catastrophic, including fatalities among personnel and damage to the vessel and its surrounding environment. Preventing overfills from occurring is one of the common safety functions performed by instrumentation within the safety system. However, when safety functionality—i.e., the high-level and overfill alarms are integrated with the tank gauging system, it creates the possibility that an instrument error or failure within the tank gauging system could also affect the safety functionality, thereby reducing its reliability. This is why full separation between the two systems is advocated as the most effective means of ensuring increased safety.

The IMO regulation that gas carriers must comply with is the IGC Code. In its current revision (2016), it stipulates that every cargo tank on board must be equipped with at least one level indicator, one high-level alarm, and one overfill alarm. The Code requires the high-level alarm sensor and the level indicator to operate independently of each other and further mandates that the overfill alarm sensor also function independently of the high-level alarm sensor. However, it does not explicitly state that the overfill alarm sensor and the level indicator must be independent of each other. Some parties have interpreted this omission as justification for integrating overfill alarm functionality within the liquid level gauging system. However, since the regulation's purpose is to maximize safety when transporting liquefied gases in bulk by sea, combining tank level gauging and safety functions appears to contradict the intent of the Code. A clarification is planned for the upcoming revision of the IGC Code, scheduled for publication in 2028. This revision will explicitly state that high-level and overfill functions must remain independent and that both must also be independent from liquid level gauging devices. This requirement is expected to apply to all gas carriers constructed after 1 July 2028.

SIGTTO

The Society of International Gas Tanker and Terminal Operators (SIGTTO) is an international organization representing a broad range of gas tanker and terminal operators. One of its primary objectives is to promote safety and operational reliability across the industry. Since 1983, SIGTTO has also held consultative status as a non-governmental organization (NGO) with the International Maritime Organization (IMO).

SIGTTO has observed that integrating safety-related functionality with tank gauging systems reflects a misinterpretation of the intent of the IGC Code. To clarify this issue and reduce the risk of misunderstanding, the society has published recommendations on emergency shutdown and related safety systems. These recommendations emphasize that overflow control and tank gauging systems must remain separate and independent of one another.

Other Regulations and Guidelines

Several international organizations have regulations and guidelines that support the necessity for clear independence between safety functionality and the tank gauging system on gas carriers. For instance, the US Coast Guard's (USCG) Code of Federal Regulations stipulates that the overfill alarm must be independent of the tank gauging system. The code states: "Independence as applied to two systems means that one system will operate when there is a failure of any part of the other system." This wording clarifies that the tank gauging system must be kept separate from the safety functions, leading to doubts that the USCG will accept integrated safety functions for gas carriers entering US waters in the long term.

Other Regulations and Guidelines

Another example is the Marine Environmental, Safety and Quality Assurance Criteria of ExxonMobil, which specifies that all cargo tanks must be equipped with an independent high-level alarm in addition to any alarms incorporated into the tank gauging system.

For land-based tanks, two safety standards typically require compliance by stating that the instrumentation used for overfill prevention must be independent of the instrumentation used for tank gauging. This ensures that a level gauging failure will not also result in a failure of the alarm functionality. Therefore, it is clear that to comply with this requirement, safety functions cannot be integrated with the tank gauging system.

The two standards are:

- The American Petroleum Institute's API 2350 standard, which provides minimum requirements to comply with modern best practices for non-pressurized above-ground large petroleum storage tanks.
- The The International Electrotechnical Commission's IEC 61511 standard, which outlines best safety practices within the process industry.

Options for Gas Carriers

Although the IGC Code states that every tank must be equipped with at least one level indicator, an independent secondary level measurement is typically implemented in addition to the primary sensor to provide redundancy. Existing solutions, where safety functionality is integrated within the tank gauging system, are either based on two radar units providing primary and secondary level measurements, with high-level and overfill alarms superimposed, or on three radar units where one of the safety functions is superimposed.

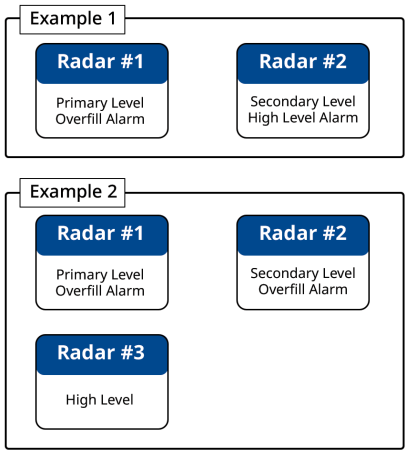

Figure 1. Integrated and dependent solutions

However, the forthcoming revision of the IGC Code will explicitly require complete independence between overflow control functionality (high-level and overfill) and other liquid level indicators. As stipulated in the report of the Drafting Group (MSC 110/WP.7, 26 June 2025), for ships constructed on or after 1 July 2028, the sensors specified in sections 13.3.1 (high-level) and 13.3.2 (overfill) must be independent of other liquid level indicators. This has always been the intent of the IGC Code, but the clarification now makes it explicit, thereby preventing misinterpretation and requiring shipyards and shipowners to consider alternative solutions.

Although still sometimes used, float-based systems have certain limitations. Float switches are simple mechanical devices that indicate the presence of a liquid and activate when the liquid reaches a defined level in the tank.

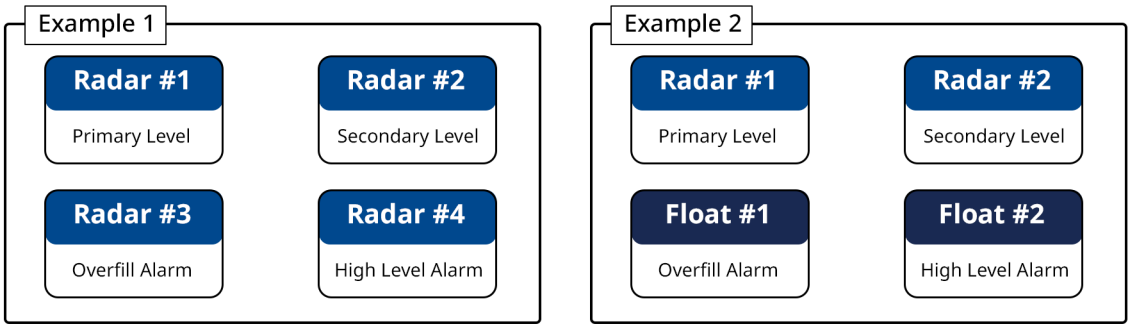

Figure 2. Fully separate and independent solutions

Their initial cost is lower than radar technology, but with several moving parts that can break under cryogenic conditions, they also have reduced reliability and may require gas-free maintenance inside the tank. When used in safety applications, such unreliability can have serious implications. In addition, safety systems require frequent proof-tests to verify correct operation, and the procedure can be time-consuming when it includes manually lifting the float elements. In contrast, radar technology can be quickly and easily proof-tested remotely from the comfort of the control room, thereby increasing worker safety and saving time. Moreover, any required maintenance can be performed from outside the tank, making the task much more straightforward.

Some solutions that are fully based on radar technology require the use of four separate radar units, each in its own housing, to provide primary level measurement, secondary level measurement, high-level alarm, and overfill alarm. Alternatively, there is the option to implement an advanced solution based on 2-in-1 radar technology. In this innovative concept, a dual radar level gauge integrates two completely independent radar units, each performing level measurements independently but housed together. Likewise, a dual overfill alarm tank gauge incorporates two fully separate and independent radar units - one providing a high-level alarm and the other an overfill alarm - within a single housing. Both of these solutions have been available and successfully used for more than 10 years. This 2-in-1 solution not only increases safety by ensuring clear independence between the tank gauging system and the safety system, but it also offers the advantage of using only two still pipes instead of four. Radar devices measure through still pipes on gas carriers because they create calmer liquid surfaces and enhance the accuracy and reliability of the level measurement. In a 2-in-1 solution, one still pipe is used for the two independent radar level gauge units, and a second still pipe is used for the two safety alarm tank gauge units. As these still pipes can be over 50 meters long, a compliant solution requiring only two of them significantly reduces complexity and costs.

Summary

The working environment on a gas carrier can be highly dangerous, and accidents can have serious consequences. Ensuring the safety of personnel, assets, and the surrounding environment is therefore the top priority. Having raised concerns about the potential implications of integrating safety functionality within the tank gauging system, SIGTTO is advocating for changes to the relevant IMO regulations. If amended, the regulations would require clear separation between the tank gauging system and the safety system. This can be achieved either by using four separate radar gauges for primary level measurement, secondary level measurement, high-level alarm, and overfill alarm, or by implementing two dual radar gauges with innovative 2-in-1 technology. Regardless of the chosen option, clear separation between the tank gauging system and the safety system eliminates the possibility that a failure within the tank gauging system will affect the high-level and overfill alarms, thereby significantly enhancing safety.

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